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METHOD AND APPARATUS FOR COUPLING AN ATM COMMUNICATION LAYER TO A PLURALITY OF TIME-DIVISION MULTIPLEX COMMUNICATION TERMINALS

BACKGROUND OF THE INVENTION

The present invention is directed to both a method and to an apparatus for coupling an

5   ATM communication layer to a plurality of mutually independent time-division

multiplex communication terminals.

Description of the Prior Art

In the asynchronous transfer mode (ATM), data is transmitted in the

ATM layer in cells of 53 bytes (48 bytes payload data and 5 bytes control data)

independently of the information they represent (voice communication, data

10   communication, multimedia). The cells are thereby not transmitted continuously but

asynchronously, or burst-by-burst dependent, on the momentary demand for

transmission bandwidth.

In order to couple such a high-performance ATM layer to terminal points

or local networks, it is necessary to divide the cell stream of the ATM layer onto a

15   plurality of time-division multiplex communication terminals (ports) that are

independent of one another in terms of time. The problem of decoupling the time-

uncorrelated behavior of the ATM communication layer with [sic!] the time-

uncorrelated cell transmission demands of the plurality of time-division multiplex

communication terminals arises. In order to thereby meet the real-time

20   demands made, for example, of the voice communication, an optimally favorable cell

delay variation (CDV) behavior must be assured. That is, the time delay of individual

cells should not fluctuate more than a defined value in order to avoid a

falsification of the time sequence of cells in the transmission of successive cells via

different communication paths.

25   For a plurality N of time-division multiplex communication terminals, it is

known to generate a waiting list having a cell rate corresponding to N-times the cell

rate of the individual ports (assuming all ports have the same, typical transmission

bandwidth). The cells waiting lists [sic] are then distributed onto the N terminals

according to what is referred to as the round-robin method. Those of the N terminals that request a cell at the moment are thereby successively serviced cell-by-cell by the waiting list in a fixed sequence. Since the N communication terminals are independent of one another in terms of time, it can occur that up to N cells are

5 simultaneously requested from the waiting list at a specific point in time. The coupling of the ATM communication layer must thus be able to "buffer" both the ATM bursts as well as the port-side fluctuations in the demand for cells. On the other hand, excessively long waiting lists lead to a deterioration of the cell delay variation behavior of the coupling.

10 The format and the specifications of the ATM layer are described, for example, in Rathgeb, Wallmeier, "ATM-Infrastruktur für die Hochleistungskommunikation", pp. 78-90, and the coupling to a plurality of time-division multiplex terminals is described in ATM-Forum, "Baseline Text for Inverse Multiplexing for ATM, AF-PHY-0086.000."

15 The present invention is, therefore, directed to a method and an apparatus for the coupling an ATM communication layer to a plurality of time-division multiplex communication terminals, whereby cell losses are avoided and the variation of the cell delay is minimized.

SUMMARY OF THE INVENTION

The problem is solved by the method defined in claim 1 and by the

20 apparatus defined in claim 10. The method comprises the method steps:

-- generating a control signal sequence with a clock rate corresponding to the overall payload cell rate CR_N of the N time-division multiplex communication terminals, whereby the control signals can represent a first or a second status;

25 -- offering a fixed data pattern;

-- transmitting the ATM cells coming from the ATM communication layer into an ATM cell waiting list;

-- transmitting, on demand, an ATM cell from the ATM waiting list to the requesting time-division multiplex communication terminal when the

respectively oldest control signal of the control signal sequence represents the first status, and transmitting the fixed data pattern to the requesting time-division multiplex communication terminal when the oldest control signal of the control signal sequence represents the second status; and

5   --   deleting the oldest control signal of the control signal sequence.

As a result of the control signal sequence, a clocking of the transmission of the communication cells from the ATM waiting list to the requesting terminal (port) is prescribed that is independent of the asynchronous delivery of ATM cells into the ATM cell waiting list as well as of the non-uniform cell demand of the N

10   ports that are independent of one another in terms of time. The control signal sequence emulates a behavior of the time-uncorrelated communication terminals (physical layer) corresponding to a terminal with N-fold bandwidth. The clock rate is thereby selected corresponding to the overall bandwidth of the n ports, so that the plurality of cells generated in the N-port waiting list is equal, on average, to the cell

15   demand of the N ports. Depending on whether an ATM cell is in the ATM waiting list or not, either this ATM cell or a fixed data pattern (stuffing cell) is transmitted. Which of the two cell contents is added to the N-port waiting list is dependent on the respectively oldest control signal of the control signal sequence. The control signal can thereby represent a first or a second status.

20   A control signal representing the first of the two statusses is preferably allocated to each cell in the ATM cell waiting list. A check to see whether a cell to which a control signal representing the first status has not yet been allocated is in the ATM waiting list is carried out at every point in time defined by the prescribed clock rate for generating a new control signal. When this is the case, a control signal, for

25   example a logical "1", representing the first status is generated, otherwise, a control signal, for example a logical "0", representing the second status is generated. The length of the control signal sequence can be selected according to the method of virtual chaining of the N communication ports and can, for example, amount to up to 3·N control signals.

The transmission of a cell from the ATM communication layer into the ATM waiting list is only enabled when the plurality of cells in the ATM waiting list minus the plurality of control signals representing the first status ("ones") is less than or equal to a number X. The lead time for the cell transmission from the ATM layer to the communication terminals can be set with X. X must be at least ≥ 1 in order to dependably assure the transmission of all cells. However, the lead time varies all the more ~~greatly~~ and the cell delay variation (CDV) behavior is all the poorer the higher X is set.

The N time-division communication terminals can be either completely uncorrelated or partly correlated with one another. The division of the cells onto the N terminals can occur ~~ensue~~ according to ~~what is referred to as~~ the round-robin method or a method that is suited dependent on the desired application.

Referring to Figure 1, the An exemplary embodiment of the present invention is described on the basis of Figure 1, which shows a schematic illustration for explaining the functioning of the inventive method and of the inventive apparatus. The data to be transmitted proceeds ~~proceed~~ from the ATM layer onto the ATM cell waiting list uncorrelated in time in units of ATM cells of 53 bytes. A clock generator circuit CLK generates clock pulses with a frequency that corresponds to the overall cell rate of all N time-division multiplex communication terminals that are connected ~~(at the right in the Figure)~~. At every point in time of a clock pulse, the inventive apparatus checks to see whether an ATM cell to which a control signal was not yet allocated is in the ATM cell waiting list. When this is the case, a logical "1" is entered into the control signal sequence as control signal. When no "new" ATM cell is in the waiting list, then a "0" is entered into the control signal sequence. This operation is repeated at every clock pulse from the clock generator circuit CLK, so that a "1" of the control signal sequence is allocated to every ATM cell in the ATM cell waiting list. When a cell request occurs ~~ensues~~ from one of the N communication terminals, then the entry in the control signal sequence decides whether an ATM cell or a fixed data pattern F, what is referred to as a stuffing cell, is transmitted. When

the foremost (oldest) signal of the control signal sequence is a "1", then, for example, an ATM cell is transmitted; ~~when~~ it is a "0", then the stuffing cell F is transmitted. The division of the cells onto the N time-division multiplex communication terminals ~~ensues~~ _occurs_ according to the known round-robin method. Subsequently, this oldest signal

5   of the control signal sequence is deleted.

In order to avoid a cell loss, the inventive coupling device checks whether the plurality of ATM cells in the ATM waiting list minus the plurality of "ones" in the control signal sequence is less than or equal to x (with x ≥ 1). When this is the case, ~~this means that~~ a maximum of one ATM cell to which a "1" has not yet been allocated

10   in the control signal sequence is in the waiting list, and ~~enables~~ _is enabled_ the transmission of ATM cells into the ATM waiting list. When the difference is greater, then the transmission is blocked until enough "ones" have again been generated in the control signal sequence.

The present invention thus enables an asynchronous coupling of an ATM

15   communication layer to a plurality of mutually independent time-division multiplex communication terminals, whereby cell losses are avoided and the cell delay time variation is kept to a minimum at the same time. The control signal sequence emulates a behavior of the N mutually time-independent communication terminals like a terminal with the overall bandwidth of all N terminals. As a result thereof,

20   bursts of the ATM layer and burst-like behavior of the time-uncorrelated terminal are decoupled from one another.